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# CONSTRUCTION OF A HAIR-HYGROSTAT WITH MAGNETIC SWITCH FOR HUMIDITY CONTROL IN AN INCUBATOR ROOM

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## Introduction

A hair-hygrostat capable of operating for long periods of time without attention either for adjustment or maintenance is described herein. The construction is simple and inexpensive and can be done with a few common tools usually found in a laboratory or work shop. Detailed descriptions and instructions for fabrication of the instrument are presented in the following pages.

Hair-hygrostats which employ exposed electrical contact points are uncertain in operation, owing to oxidation and sticking of the contact points. In addition to this uncertainty of operation there is a hazard to humidifying equipment, such as bearings, valves, and motors, due to excessive operation when the hygrostat fails to operate properly.

This hair-hygrostat has a hermetically sealed mercury contact switch which is not affected by dust, dirt, or corrosion. The switch is operated by a magnet mounted outside the glass tube containing the switch.

This hair-hygrostat has been in constant operation in an incubator room at the New Haven, Conn., field station for a period of 5 months, during which time its reliability has been demonstrated. Humidity has been maintained within a range of 2 percent, from 92 to 94 percent relative humidity (hygrograph record), in a room 13 feet long, 8 feet wide, and 7 feet high, utilized in conducting genetic studies of the European corn borer. Drops in humidity of greater magnitude (below 92 percent relative humidity) sometimes occur when the incubator-room entrance door is opened at too frequent intervals. However, the humidity conditions are again regulated without attention to the instrument when the room is closed.

## Material Required for Construction

The following materials were used in constructing the hygrostat:

| Item | Amount | Use |
|---|---|---|
| Specific essential parts: | | |
| Hermetically sealed mercury contact switch with supporting clamp, having electrode and armature actuated by a permanent magnet | 1 unit | Hygrostat switch |
| A permanent magnet and mounting arm designed to operate the mercury switch | 1 unit | Switch operator |
| Stabilizer and guide with stop head for magnet mounting | 1 unit | Switch operator guide |
| Nonspecific parts: | | |
| Presswood board | $\frac{1}{8}$" x 11" x 18" | Nonconducting base and back |
| Enamel paint | $\frac{1}{4}$ pint | Finish for base and back |
| Small brass cabinet hinge | 1 | Hinge for magnet arm |
| Brass post with threaded hole in basal end and slotted horizontal hole near top | 2 | Stationary mounting for hair and spring adjusters |
| Music-wire spiral spring | 1" long | Differential adjuster |
| Round-head machine screws 1/16" x 3/4" | 6 | Fastening parts to base and back |
| 1/16" x $1\frac{1}{2}$" | 2 | Hair and spring adjuster |
| Wire nails $\frac{1}{2}$" | 2 dozen | Fastening presswood together to form base and back |
| Strand of human hair | 50 hairs 9" long | Moisture-sensitive unit to operate switch |

## Description of Specific Essential Parts

The hermetically sealed mercury contact switch is one which remains in a fixed position and operates by magnetic attraction through the glass wall of the switch tube. Specifications are: Electrical capacity 9/10 amperes, 24 volts; maximum capacity 1/60 horsepower.

The permanent magnet should be one designed to operate the switch which is used. The magnet is mounted on an arm to be attached to the actuating mechanism of a thermostat and can be easily attached to a hinge for use in this hygrostat.

The stabilizer and guide with stop head for magnet are made to fit on the upper end of the magnet arm and maintain the magnet in its proper position in relation to the switch.

## Method of Construction

The construction will be clarified by reference to figures 1 and 2, wherein the various parts discussed are labeled.

The base of the hygrostat, which is $2\frac{5}{8}$ inches by $13\frac{1}{2}$ inches, and the back, $3\frac{1}{2}$ inches by $3\frac{3}{4}$ inches, are constructed by nailing together 3 layers of presswood board and nailing the back to the base as illustrated. After the necessary holes for machine bolts are made, as indicated below, the base and back are painted with several coats of black enamel. This provides an inexpensive, rigid, insulated frame for supporting the operating parts.

The mercury switch is a type commonly used with a bimetallic coil in commercial heating plants for dwellings. The essential features for the present purpose are the hermetically sealed mercury contact points and the magnetic actuating device. A clamp for supporting the switch (glass tube) is attached by machine screws to the back so that the switch is supported at the proper angle for operation.

A wire, 1/32 inch by $\frac{1}{2}$ inch, with ends curved to serve as hooks for attaching the hair and spring, is soldered into a hole $\frac{3}{8}$ inch from the lower end of the magnet arm. The magnet arm is then soldered to one side of a hinge. The proper position of the magnet and its supporting arm for operating the switch is determined by holding the hinge on the base with the hand. When the proper position has been determined, the hinge is fastened to the base with a machine screw. The stabilizer, guide, and stop head consist of a single unit as used in a thermostat employing this type of switch. This unit is placed in the proper position in relation to the magnet and attached to the back by a machine screw. The connecting wires from the switch are fastened with machine screws to the face of the back. These screws project through the back and serve as binding posts for wires to the relay transformer which actuates the humidifying unit.

The two brass posts are 1½ inches long and ⅜ inch in diameter, with a hole in the basal end threaded to receive a 1/16 inch by ¾ inch machine bolt and with a slotted hole, i.e., straight on one side, to receive a 1/16 inch bolt. They are attached with machine screws near the ends of the base and in line with the hinge attachment. The two long machine screws are flattened so that they can slide through but not rotate in the slots at the tops of these posts. They are provided with hooked ends for attachment of the hair and spring. Two nuts on each of these screws hold the screws at desired distances through the slots and serve as spring and hair adjusters. The spring and hair are attached to their respective adjusters and to the hooks near the base of the magnet arm.

The strand of hair consists of 50 human hairs, treated with ether to remove all fats and dirt, looped at the ends, and fastened with household cement to form eyes for attachment.

## Operation and Adjustment

As humidity in the room decreases, the strand of hair dries. This causes the hair to contract, pulling the arm and magnet toward the moveable electrode (armature) of the switch. The magnetic field of the magnet pulls the moveable electrode toward the magnet, and the mercury on this electrode contacts with the stationary electrode, thus completing the circuit to the relay. The relay then closes the circuit which operates the humidifier.

As the humidity in the room increases, the strand of hair becomes moist. This causes the hair to expand, and the spring pulls the arm and magnet away from the moveable electrode. When the magnet has moved away from this electrode until its magnetic field is weaker than the pull of gravity on the electrode, the electrode drops back to its original position and breaks the circuit to the relay, thus stopping the humidifier.

The hygrostat is set by simultaneously adjusting the spring tension, which controls the differential within which the instrument operates, and the hair adjustment, which controls the set of the instrument until the desired percentage of humidity and differential are obtained.

## Utility of the Instrument

The hermetically sealed switch has a long life under the most strenuous usage.

The instrument has a wide range of possible adjustments, since the spring tension and hair balance for various ranges and settings are practically unlimited. By reversing the relay switch and connecting a drier (any dehumidifier in which air is circulated through an apparatus designed to remove moisture from the air, with the air-circulating device actuated by the hygrostat, can be adapted for this purpose), the same hygrostat can be used for dehumidification where this type of control is desired.

# HAIR HYGROSTAT WITH MAGNETIC SWITCH

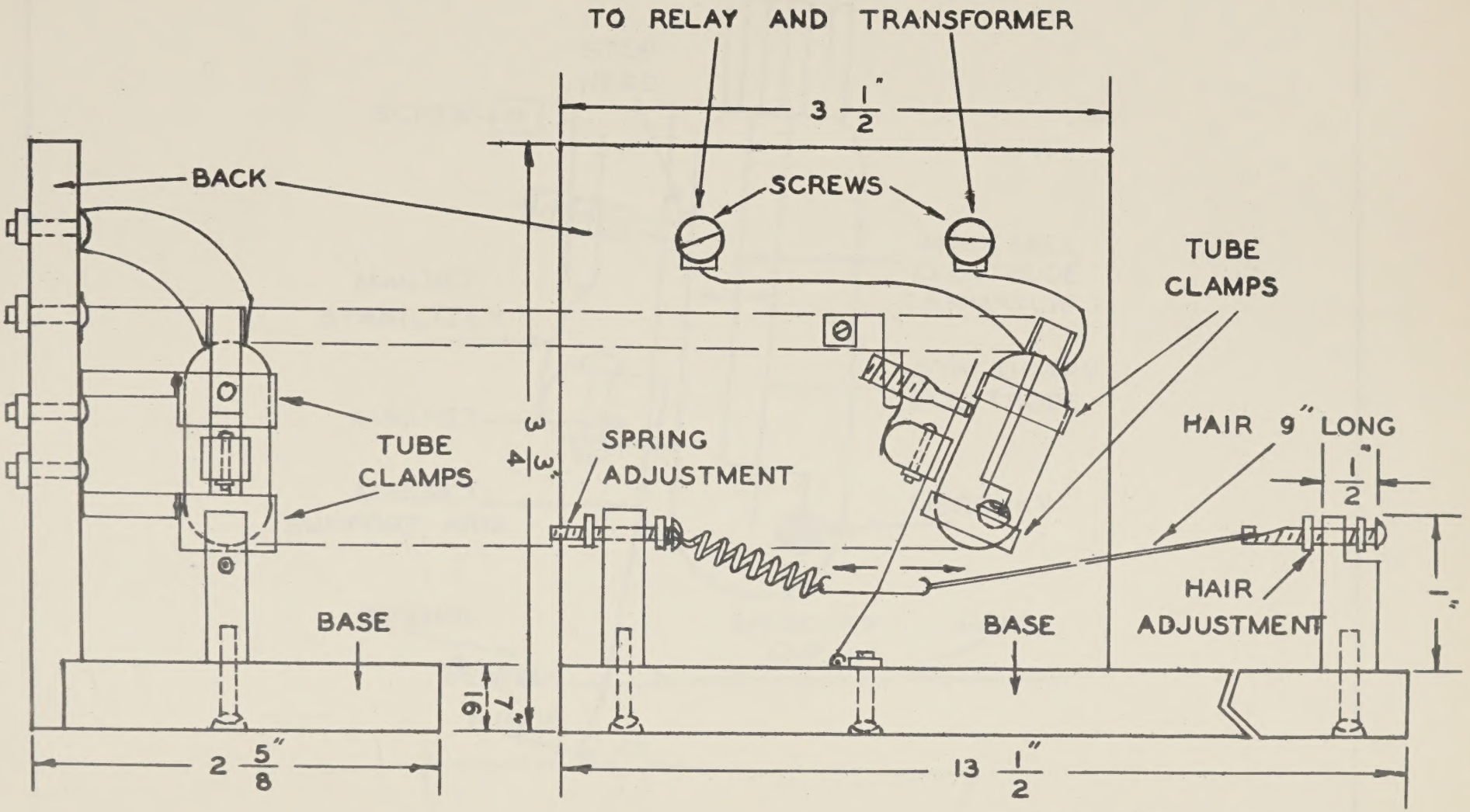
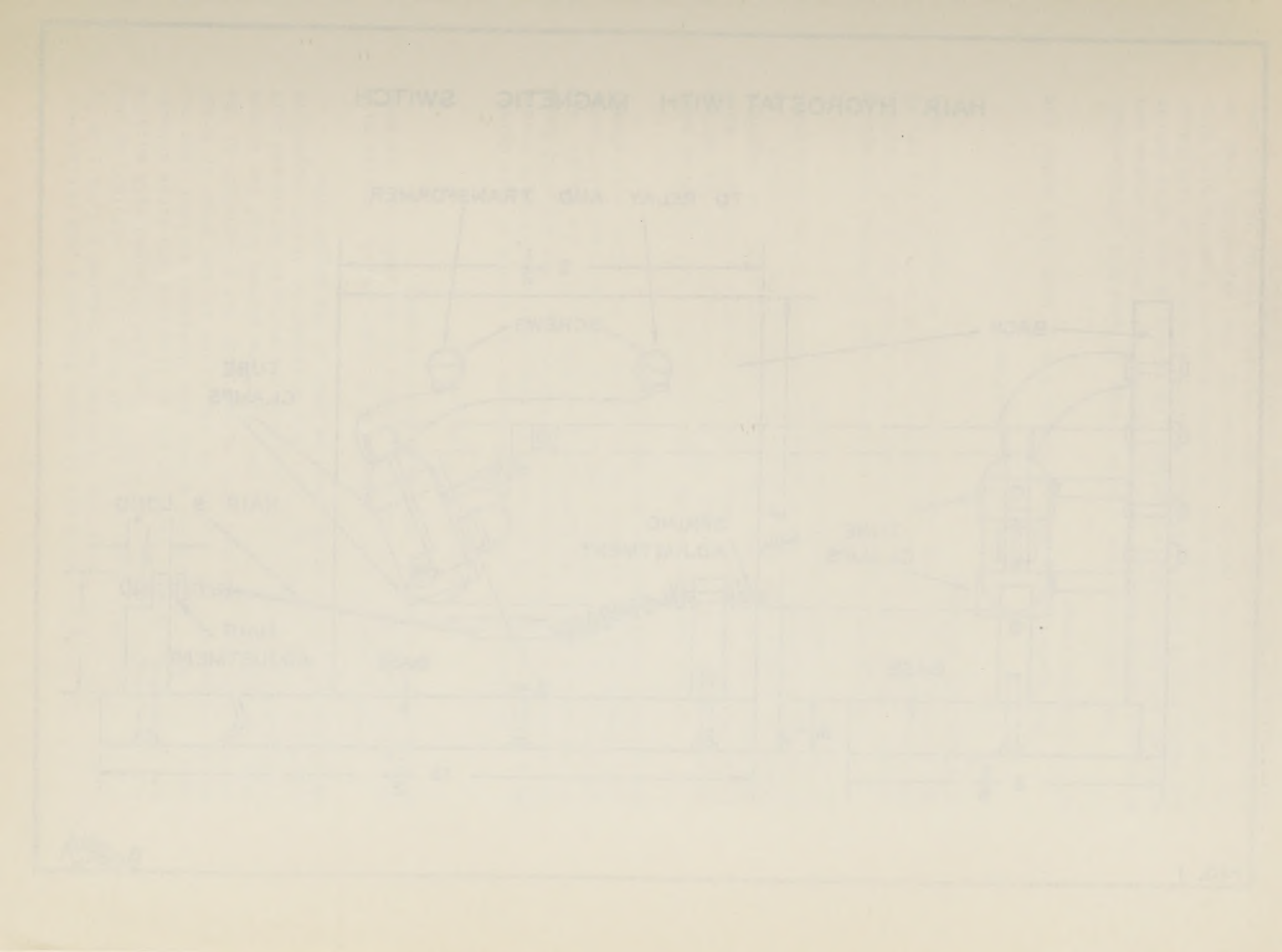



FIG. 1



# DETAILS OF MAGNETIC SWITCH AND MAGNET SUPPORT

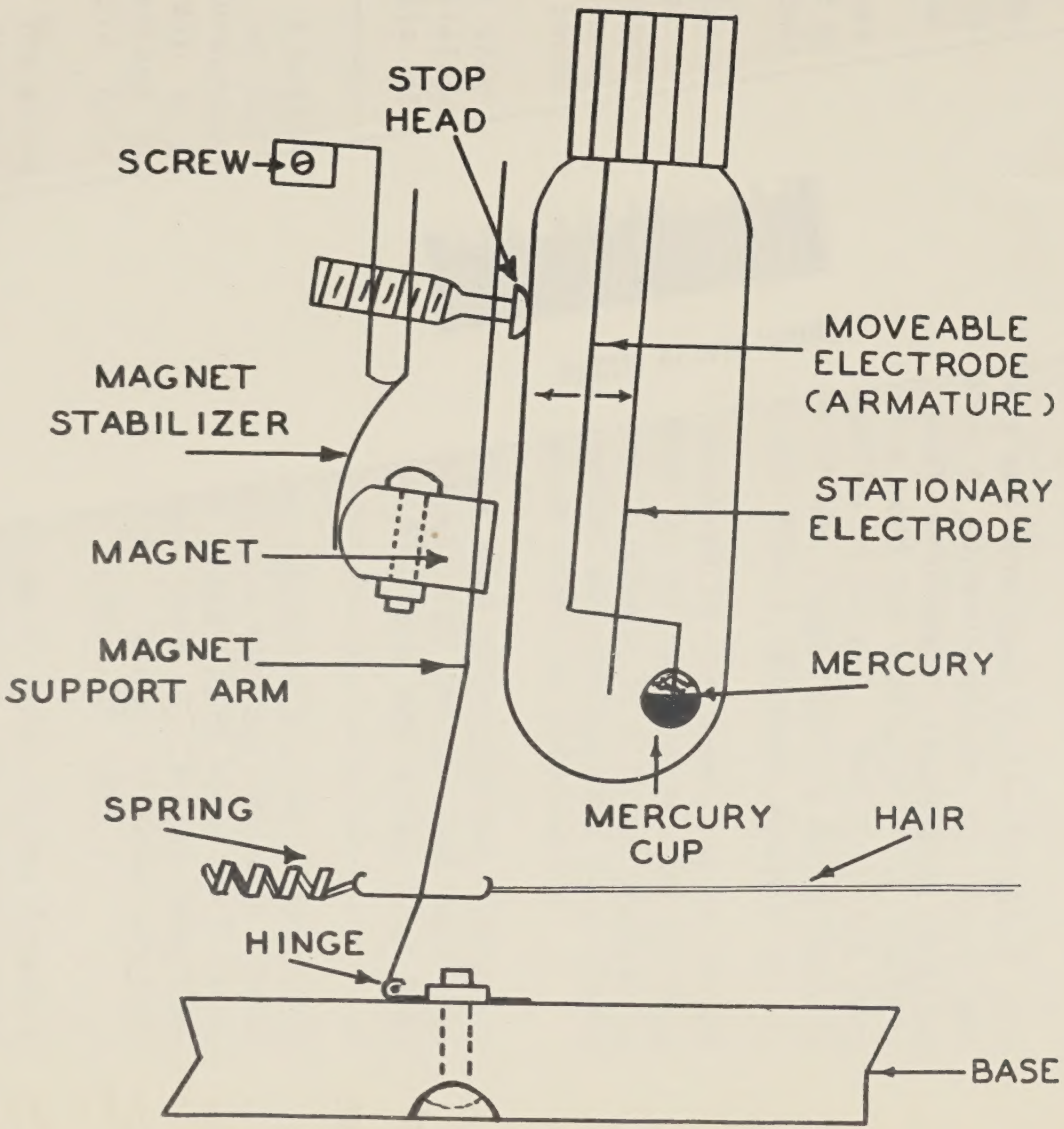



FIG. 2